

***REVIEW OF THE DEPARTMENT OF ECOLOGY'S
IMPLEMENTATION OF NEW AGRICULTURAL
BURNING RULES FOR CEREAL GRAINS.***

FALL BURN SEASON 2006

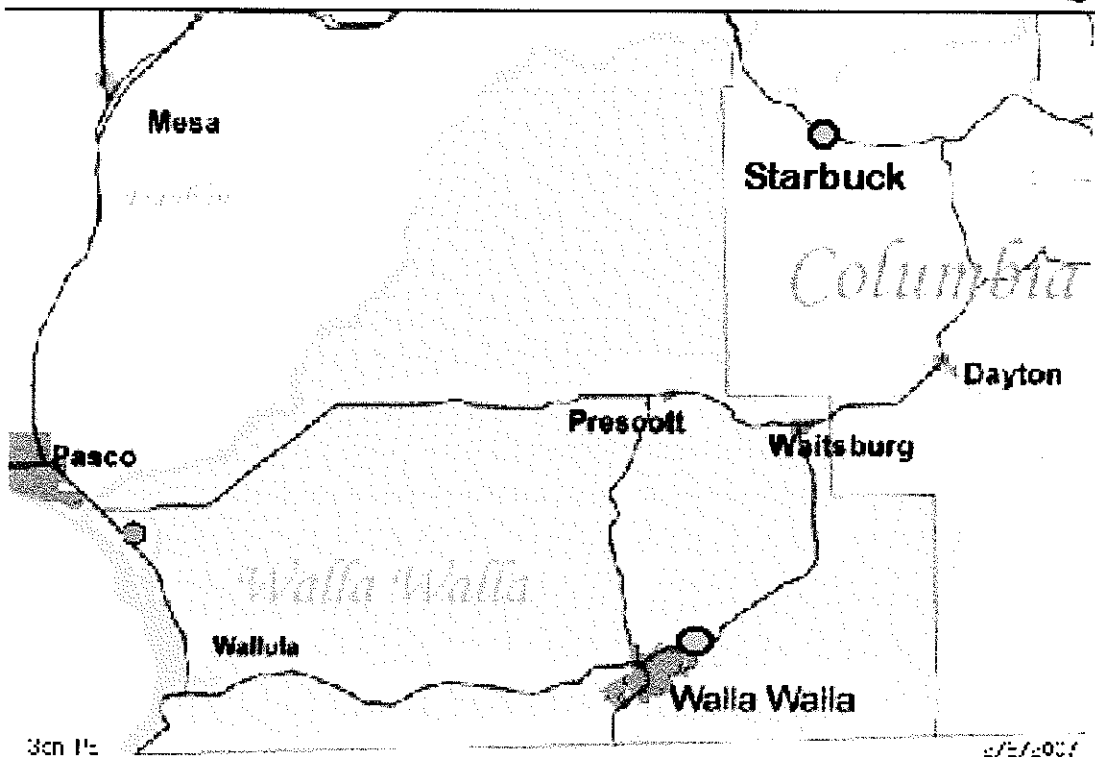
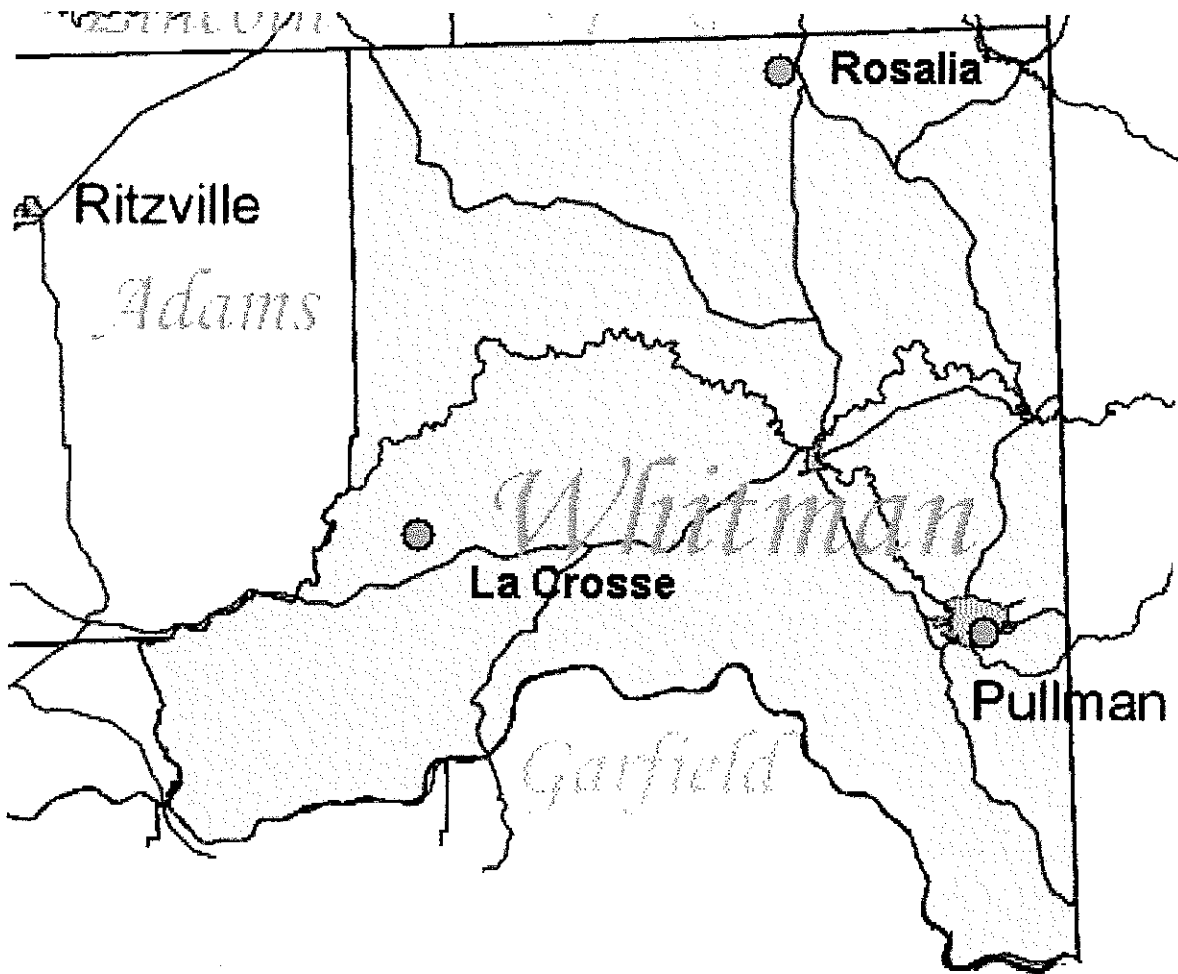


BY TIM CONNOR

For Save Our Summers

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INTRODUCTION AND SUMMARY

In August 2006, the Department of Ecology began implementing new provisions of WAC 173-040, the revised administrative rules for regulating agricultural burning under the state's Clean Air Act (RCW 70.94). A central feature of the new rules is a smoke management index developed pursuant to a November 2001 settlement agreement between Ecology and Save Our Summers. The index is a management tool that also serves the purpose of giving the program more transparency for how burn decisions are made and whether the decisions are successful.

The purpose of this review was to evaluate the fall burn season and, specifically, to look at how the agricultural burning unit based in Ecology's Eastern Regional Office integrated the new rules into their already intensive daily responsibilities. The new rules require "yellow" sheets to be filed when burning is authorized at times when air quality has been marginal but is expected to improve. A "red" sheet is required if--subsequent to a yellow sheet being filed--air quality continues to significantly deteriorate.

Save Our Summers wanted to know if the new rules were workable. More importantly, SOS wanted to know what the records showed about the kinds of decisions the Ag Burn Unit made and whether those decisions succeeded in keeping field smoke at or below the threshold levels described in the new rules.

At Ecology's suggestion the work plan was expanded to include a detailed examination of air monitoring data to see if Ecology had missed yellow and red sheet events and, if so, how many. Accordingly, hourly data from five monitoring locations (LaCrosse, Pullman, Rosalia, Starbuck, and Walla Walla) was carefully examined and matched up with the record of daily burn decisions. The locations were selected because they are located in areas where most cereal grain burning occurs.

The findings of this review should be encouraging to anyone with a stake in the field burning program. Even though Ecology permitted 215,165 acres for agricultural burning in eastern Washington in 2006, there were relatively few instances where "yellow" sheet burns were authorized, and no instances in which "red" sheet episodes were attributable to authorized burning. This was true even though regional wildfires (e.g. the Columbia Complex fire near Dayton) resulted in a large number of no burn days in counties where there is high demand for cereal grain burning.

The narrow questions of whether the new rules are manageable and effective are easily answered. The answer is yes. More importantly, the review supports a finding that Ecology's burn decisions are well in synch with the intent of the statute to err on the side of protecting air quality while accommodating agricultural burning where it is deemed necessary. On a day to day basis, the Ecology decision-making process is a remarkable, and gradually improving, exercise that must account, daily, for literally hundreds of facts and reconcile clearly competing pressures. On this level, the program is succeeding in ways that should make it a model for the nation. Yet, as the program decision-makers

are the first to acknowledge, even small mistakes can have unwelcome public health consequences because of the potential for acute exposures to individuals. It is in that context that the problems identified in this review should be considered.

Unfortunately, what this review doesn't address or resolve is the clearly disconcerting reversal in the trend toward fewer acres burned--a goal that Ecology publicly committed itself to in 1999. The cereal grain burn acreage in 2006 (182,543 acres, 180,173 of which were wheat) represented nearly a 50% increase above the cereal grain acres permitted acres in each of the three previous years. It is significantly higher than the 125,000 acre goal of the voluntary memorandum of understanding that the agency entered into with the Washington Association of Wheat Growers seven years ago. Thus, it raises a number of questions for the future given Ecology's past emphasis on acreage reductions as the primary method for reducing air pollution from cereal grain burning. (See Attached guest column by Director Fitzsimmons, 4/99)

Recommendations

1) The burn call should not be made before Ecology staff has a reasonable period of time to evaluate the GFS ventilation model. Given that people with direct health concerns and growers both have an interest in the quality of the burn decision, an extra 15 to 30 minutes does not seem unreasonable.*

2) To the extent practicable, Ecology should continue to make improvements in managing the information necessary to determine when yellow sheets are called for under WAC 173-430-040. A computer program that would automatically calculate rolling 2-hour averages and visually alert the burn team when a threshold is reached would be ideal.

3) The requirement of WAC section 173-430-040 (b) (ii) is vague as to whether the requirement is to account for the past 24 hours or the past 30. More to the point, it's hard to imagine a circumstance in which looking back 30 hours adds value to the decision-making process. For practical purposes, looking back 24 hours at the 2 hour averages is more than sufficient and any computer software upgrades should limit the window of data being rolled up to the past 24 hours before the burn call.

4) When yellow and red sheets are filed, all sections of the forms should be filled out.

5) Because of the importance of carefully evaluating red sheet events, (i.e. to be able to determine whether or not authorized burning contributed to high PM 2.5 levels) the sheets should not be finalized until the post-burn reports have

been received and information on burn acreage, wind direction, etc., is entered on the red sheet.

*There doesn't appear to be anything in the 2001 Settlement Agreement with SOS that prohibits moving the deadline for the burn call from 9 a.m. to 9:15 or 9:30 a.m.

Scope of the Review

In addition to assessing the yellow and red sheets placed in the file during the late summer/fall burn season, hourly air monitoring data from five stations were reviewed to determine the extent to which yellow and possibly red sheet filings had been missed. Smoke complaints received during the period were reviewed and interviews were conducted with Ecology staff.

Part 1

REVIEW OF YELLOW SHEET/RED SHEET FILINGS

YELLOW SHEET #1

September 9, 2006, Burning authorized in Adams County & Zone 4 Whitman County

Facts: A yellow sheet was required because of high daily and 2 hour PM 2.5 averages at Adams and Whitman County stations on September 8th. High values recorded in Pullman and Rosalia on the day of the burn were registered *before* the authorized burns occurred and values had declined into the single digits by the afternoon.

*Analysis: **Successful Burn.** Ecology recognized a limited window (in the prevailing stagnation with smoke from wildfires) for limited burning and succeeded in allowing the burn without adversely affecting area air quality. It's a good example of how the system can work even under difficult conditions.*

YELLOW SHEET #2

September 12, 2006, Burning authorized in Whitman and Walla Walla Counties

Facts: A yellow sheet was required because of high daily and 2 hour average values recorded at Whitman County monitoring stations on September 11th. The reported burning allowed was a 284 acre burn in Whitman Co. Zone 7 (NE

Whitman County) and a 150 acre metered burn in Zone 8 (East Whitman County). It is not clear why Walla Walla was listed on the yellow sheet because air quality readings in Walla Walla would not have warranted a yellow sheet and neither is there any record of allowed burns in Walla Walla on the 12th.

*Analysis: **Successful burn.** The high values recorded at the Pullman monitor on the 12th occurred in the morning and PM 2.5 values had fallen to 6 µg/m³ by 5 p.m. (post-burn).*

YELLOW SHEET #3

September 13, 2006, Authorized bluegrass burn, Whitman County, Zone 3

Facts: This was a 42 acre bluegrass burn south of Colton authorized because the field qualified for the slope exception in the grass seed burn rules. The yellow sheet was required because both the Pullman and LaCrosse monitors had high 24-hour and 2-hour values on September 12th. By the morning of the 13th, however, the PM 2.5 values were in the single digits at both locations and declined throughout the day.

*Analysis: **Successful burn.***

YELLOW SHEET #4

September 19, 2006, Authorized limited burning in Walla Walla County that could have affected Starbuck in Columbia County, where a burn ban was in effect.

Facts: The yellow sheet was required because of a 2-hour average spike at Starbuck on the morning of September 18th (22.5 µg/m³, the yellow sheet threshold is 22 µg/m³). Walla Walla readings were considerably lower.

*Analysis: **Successful burn.** However, it was not clear from yellow sheet what and how much was burned where. The yellow sheet entry should have been more thorough.*

YELLOW SHEET #5

October 24, 2006, Region-wide burning allowed with a 150 acre limit per grower.

Facts: Burning was allowed because a strong weather front was forecast by the afternoon. The yellow sheet was required because readings at the Spokane monitor on the 23rd were high enough to hit the triggers for 24-hour and 2-hour PM 2.5 averages.

*Analysis: **Successful burn.** PM 2.5 readings at the Spokane monitor on the afternoon of the 24th were in the single digits. The high hourly readings (i.e. 33 $\mu\text{g}/\text{m}^3$) that pushed the average up for the 24th occurred in the morning, before burning had begun.*

Analysis: Successful.

YELLOW SHEET #6 /RED SHEET #1

October 28, 2006, Burns authorized East and Southeast of Walla Walla, 100 acre limit.

Facts: A yellow sheet required for this burn call because of a 2-hour "bump" in PM 2.5 levels detected at the Walla Walla monitor early on the morning of the 28th. Burning was authorized for Zones 26 and 27 because ventilation was expected to improve with winds out of the SW and, thus, away from Walla Walla. The red sheet on this burn call was required because at 8 p.m. in Walla Walla on the 28th, PM 2.5 levels hit a 2-hour average of 34 $\mu\text{g}/\text{m}^3$, just above the 32 $\mu\text{g}/\text{m}^3$ threshold.

Analysis: Despite the red sheet, this appears to have been a successful burn because the smoke causing the evening "bump" in PM 2.5 levels in Walla Walla appears to have been from sources inside the city. Information provided Ecology from the Walla Walla code enforcement office was that there was a wine festival in Walla Walla that evening and the recreational burning associated with the festival added to smoke levels caused by fireplaces and wood stoves. The Saturday night hourly PM 2.5 readings in Walla Walla, beginning at 6 p.m. were 24,23,24,26,28,40,23. By 8 a.m. Sunday, the hourly average was back down to 6. In retrospect, however, the red sheet analysis should have been kept open at least until the post-burn reports came in from the growers. The acreage burned and the wind direction (and other observations) may have been useful in determining whether the burns were a likely or significant contributor to the smoke levels in Walla Walla that evening. Although the available information indicates that the field burning was unrelated to the high

hourly readings in Walla Walla, the very fact that a red sheet was necessary under the rule logically suggests that all the required information, including the post-burn reports, should be included in the analysis even if the incident was not a serious one and did not result in any complaints.

YELLOW SHEET #7

November 1st, Burns authorized in central Whitman County

Facts: The authorized burning was limited to two fires south of Dusty in south-central Whitman County, one of 200 acres and another of 1 acre, and a 30 acre fire near St. John in north central Whitman County. Burning was restricted to 11 a.m. to 2 p.m. The yellow sheet was required because of a 33.5 $\mu\text{g}/\text{m}^3$ 2-hour average in Pullman during the morning of October 31st. From the yellow sheet it was reported: "Wind direction away from Pullman. Burns small enough to cause very little if any impact on populated areas."

Analysis: Although this appears to have been a successful burn it also appears to have been a close call. Although the Pullman monitoring data for the period after the burn is acceptable (with levels rising only to 21 $\mu\text{g}/\text{m}^3$ in the afternoon), at the Starbuck monitor to the south and east of the Dusty burn the PM 2.5 concentrations stayed just below the post-burn "trigger" for a red sheet (a 26.5 2-hr rolling average on 11/2 as compared to the 32 $\mu\text{g}/\text{m}^3$ trigger level). This raises a question as to why the Starbuck monitor was not listed on the yellow sheet as being relevant to the burn call and the subsequent evaluation. Given the information on the yellow sheet (that the wind direction was away from Pullman) it seems plausible that the wind could have taken the smoke into northern Columbia County and Starbuck. At a minimum, a more precise statement of wind/plume direction should have been reported on the yellow sheet.

YELLOW SHEET #8/RED SHEET #2

November 2, 2006, Limited burns in Walla Walla & Whitman Counties

Facts: The yellow sheet was required because of high 24-hour averages for PM 2.5 at the Rosalia, Pullman, and Walla Walla monitors. The average in Pullman and Walla Walla was right at the 16 $\mu\text{g}/\text{m}^3$ threshold, and it was 17 in Rosalia.

The red sheet was required because the 2-hour average in Walla Walla reached 38.5 on the afternoon of November 3rd. Because none of the authorized burns actually took place, there was no connection between the authorized burning and the elevated PM 2.5 levels that required the red sheet filing.

Analysis: In retrospect, it's pretty clear the burn would not have been allowed if Ecology knew that the expected improvements in ventilation were going to occur later than was forecast. Although the red sheet was required because of the readings in Walla Walla, it's important to note that none of the authorized burns actually occurred and, therefore, could not have contributed to the high PM 2.5 values measured at Walla Walla on November 3rd.

ADDITIONAL NOTES: Much higher values were being recorded in Spokane on November 1: Maximum hourly of 47 $\mu\text{g}/\text{m}^3$, 24-hour Average of 28 $\mu\text{g}/\text{m}^3$. But the relevant values, given the burning that was allowed, were those from Whitman and Walla Walla County. According to Ecology, the permission given to growers to burn on November 2 was with the understanding that if they did not observe the expected improvement in meteorological conditions they would not burn. And, as it turned out, none of the three growers (one in Whitman, two in Walla Walla) did burn. The City of Colfax was also allowed to ignite a pile burn with an east wind.

Part 2

REVIEW OF PM 2.5 DATA AND BURN CALLS TO DETECT MISSED YELLOW AND RED SHEET EVENTS.

The purpose of this task was to select a broad sample of air monitoring data and review it to evaluate the extent to which the Ecology ERO burn team missed "yellow sheet" and "red sheet" calls during the fall 2006 burn season. Five monitoring stations (LaCrosse, Pullman, Rosalia, Starbuck and Walla Walla) located in two of the most active burn areas were selected and reviewed.

The monitoring data (August thru Mid-November) were first reviewed to identify those days where a yellow sheet would have had to have been filed if burning were allowed in the general vicinity of one or more of the five monitoring stations. After this step, the compilation of burn calls was reviewed to eliminate those days when either a burn ban was in effect or the daily burn call prohibited burning.

Factoring in "no burn" and "burn ban" days, there were approximately 250 daily decisions, over the 122 days being reviewed in this section, on the assumption that each of the monitoring stations data was reviewed before making decisions to allow burning.

Summary of Findings: The review found at least three missed yellow sheet burns and a fourth situation in which a decision to allow limited burning (under yellow sheet conditions) was made, but no growers had fields ready to burn. The error rate reflected is well under 5% and should improve as additional analytical tools are put in place.

1) August 9 (Rosalia). Ecology records show burning was allowed from 10 a.m. to 4 p.m. in Whitman County. However, Ecology also reports that there were no active permits in Whitman County at this time, so there was no authorized burning that could occur on this day for this area. The burn call was made 26 hours after the 2-hour peak (early in the morning of August 8th) in PM 2.5 concentrations. A literal reading of the rule is that had the peak fallen within 24 hours, the yellow sheet was mandatory, but between 24 and 30 hours, it was discretionary.

Finding: No yellow sheet required.

2) August 22 (Pullman, LaCrosse, Rosalia) Because the decision was to allow burning from noon to 4 p.m. this was a missed yellow sheet. For reasons cited above, the requirement for the yellow sheet holds even though there were no burns reported and no active permits listed. The pertinent triggers on the 21st were: Rosalia 24 hr. avg. of 18, LaCrosse 24 hr. avg. of 17, Pullman 24 hr. avg. of 17.

Finding: Missed yellow sheet for Whitman County. No red sheet required.

3) October 5 (Rosalia). A yellow sheet was required because of a 15, 75, 16 µg/m³ sequence in the noon to 2 p.m. run on October 4. None of the burns allowed was near Rosalia, but this was by chance because the burn call, to allow metered burning, applied to all Whitman County zones.

Finding: Missed yellow sheet. No red sheet required because of improved air quality in the post-burn period.

4) November 19 (Rosalia, Starbuck, Walla Walla) Burning was allowed on a limited basis for several counties, although records indicate nothing was burned. Still, a yellow sheet should have been filed because triggers (2 hr. avg. in Rosalia, 24 hr. avg. in Starbuck, and 24 hr. Avg. Walla Walla) were passed on the 18th. A blank yellow sheet was in the burn file, but had not been filled out.

Finding: Missed Yellow Sheet. No red sheet required because post-burn readings showed declining PM 2.5 levels.

5) November 20, (Walla Walla). The 20th is listed as a "Metered 0" day for Walla Walla County which, according to Ecology, means that limited burning would have been allowed if one or more growers wished to burn. In this instance,

none did but it's not clear that Ecology had detected the requirement for a yellow sheet if burning had occurred.

Finding: Possible missed yellow sheet.

Part 3

EVALUATE COMPLAINTS

The purpose of this task was simply to review the number of agricultural burning smoke complaints that Ecology received during the fall burn season and to see if the complaints provided useful information for evaluating burn calls and/or compliance issues.

There were only two complaints logged in the period from August through the end of November and both came from the same person in Dayton, Washington. The first complaint was logged on 9/23, a day when there was no burning in Columbia County but limited burning in Whitman and Walla Walla Counties. The logged complaint also reported ash falling in the Dayton area on 9/24, but Ecology's log sheet indicates that the 24th was a no burn day throughout Eastern Washington.

The second complaint was registered on October 6th, a day on which there were large metered burns allowed in Columbia County (1,226 acres) and Walla Walla County (1,000+ acres). By this time, Ecology had positioned its mobile air monitor in Dayton, and the results clearly show that the PM 2.5 levels rose sharply in Dayton on October 6th as a result, according to Ecology, of the authorized field burning. According to a 15 minute interval record, the PM 2.5 level at the mobile station in Dayton exceeded 50 $\mu\text{g}/\text{m}^3$ shortly after 4 p.m. the afternoon of October 6th before dropping, rather quickly, down below 15 $\mu\text{g}/\text{m}^3$. This peak, on an hourly basis, averaged out at roughly 33 $\mu\text{g}/\text{m}^3$ and the 24 hour average was well below 20 $\mu\text{g}/\text{m}^3$. The complaint and the data available from the mobile unit highlight the delicate balance that exists in the agricultural burning program even under the new regulatory program. Even though the burns were well within the compliance parameters, it's still possible that such burns may result in short-term smoke intrusions that are noticeable to people, measurable by monitors, and unhealthy for sensitive individuals.

Ecology staff reported there were at least two additional complaints that did not get recorded. By comparison, Ecology recorded 12 agricultural burning complaints in 2005, 31 in 2004, and 12 in 2003.

Part 4

EVALUATE TRANSPARENCY AND MANAGEABILITY

Transparency

The main obstacle to transparency in agricultural burning decisions is the volume of meteorological, monitoring, and permit information that is ordinarily consulted in making the daily burn calls. To be sure, the problem is not a reluctance on Ecology's part to share information. To the contrary, over the past two years the ERO officials assigned to agricultural burning have welcomed scrutiny and input on how best to manage the program and evaluate how well it is working. Specifically with regard to the information required to evaluate the fall 2006 burn season, the staff was always responsive to requests for information.

At a minimum, these are the categories of information necessary to evaluate the program's effectiveness.

- 1) A summary of the forecast meteorology used to make a daily burn decision. When PM 2.5 pollution levels reach unexpected levels after a burn decision (even if those levels are within the rules) it is important to have enough information to determine whether the meteorological information was accurate.
- 2) Hourly PM 2.5 data from the network of air monitoring stations.
- 3) A clear compilation of the daily burn decisions for each of the zones in which permitted burning can occur.
- 4) A completed yellow sheet when a yellow sheet is required by rule.
- 5) A completed red sheet when a red sheet is required by rule, or deemed necessary to evaluate an important unexpected air pollution event.

The main problem detected in this review were yellow and red sheets that had been filed but not adequately filled out. The problem is not with the sheet (it asks merely five questions) and the number of sheets to be filed (less than a dozen for the 4 month period evaluated) is small. The yellow and red sheets are important both for external transparency and internal tracking purposes, and both purposes are defeated if the sheets aren't properly filled out.

Manageability

The monitoring and forecasting tools the agricultural burning team now has at its disposal are remarkable and significant improvements continue to be made in how the information is used. The problems with the current system are of the sort you'd expect given how rapidly the program has changed in recent years to implement the metering system and the new smoke management objectives. And while it's important to view the problems in that context, it's also important to recognize (as Ecology does) that even one mistake can have serious consequences.

One weakness in the current system is that the information is not yet synchronized as well as it could be to make the best decisions and investigate unusual events. Another weakness is the inconsistency noted above in the completion of yellow and red sheets. The best way to explain and address these weaknesses is to review them in the context of what the decision-making is trying to accomplish and how it actually has to work on a day-to-day basis.

Making informed decisions

Because both growers and people with health concerns about field smoke have come to rely on it, Ecology tries to make its daily burn call at 9 a.m. This is not a problem on most days. But some days it is, and here's why. Ecology uses two meteorological models (the NAM and the GFS) to guide its burn decisions. Both models provide a regional ventilation projection that is displayed geographically and sequentially so that a user can "look" out 12 hours at the forecast ventilation conditions. (Ventilation conditions determine how well smoke from field burns will lift and disperse) Both models are useful but, according to Ecology, they don't always agree and when they disagree the GFS appears to be more reliable, especially when it is projecting less favorable ventilation conditions than the NAM.

For reasons beyond Ecology's control, the most current GFS model runs are not available to Ecology until shortly before 9 a.m. for most of the year. Thus, when the models aren't in agreement, Ecology finds itself in the difficult position of trying to understand discrepancies and factor them into burn call decisions in the space of a few minutes.

Just as a matter of chance, we chose the morning of October 18th to monitor the daily burn call. October 18th was one of the days when the models did not agree. The NAM model predicted favorable ventilation conditions throughout most of eastern Washington, with the most favorable conditions toward the southeast quadrant of the state. The burn call had been made before a more thorough comparison of the two models revealed that the GFS projection--while showing fairly good agreement with the NAM model over most of the state--indicated a much quicker deterioration of ventilation conditions in Whitman County. The result is that Ecology allowed burning in Whitman County on the

basis of a false indication from the NAM model that ventilation would be good that afternoon when, in fact, it was poor. The GFS model had it right. The PM 2.5 levels at the Pullman monitor tripled, going from an hourly average of 6µg/m³ at 11 a.m. to 18 µg/m³ by early afternoon. While no complaints were received, followup with a Save Our Summers member in Pullman not only confirmed that a smoke intrusion was noticeable (she reported being “startled” by the sudden pollution increase) but that it even prompted her to conduct a brief search to determine if a wood stove was the cause.

There was a moderating factor. Because of wet conditions in northern Whitman County, Ecology was confident that burning on the 18th would be limited because many fields were too wet to ignite. Still, the fact remains that the burn call was made on the basis of a bad model projection.

The key ingredient was time, specifically the lack of time between the time when the latest GFS model run became available and the time at which Ecology needed to post its burn call. By 9:10, there'd been enough time to study the GFS and recognize the problem. In fact, once a careful examination of the two models was completed it was clear that Ecology would like to have made a different burn call. But it was too late. An obvious solution is to either get earlier access to the latest GFS model run, or move the burn call back.

According to Ecology, getting the GFS earlier is not possible. The model runs serve a variety of subscribers and the distribution time is fixed. The GFS updates are set to Greenwich Mean Time so that when users revert to standard time in the fall, the model run becomes available an hour earlier. Unfortunately, beginning in 2007 Daylight Savings Time starts a month earlier and runs into early November. Thus, nearly all of the field burning will take place on days when the GFS update comes out right on top of the burn call, literally giving the burn unit minutes to sort out any discrepancies with the NAM model run. Suffice to say, that's not good.

Absorbing the Data

One of the key questions is whether the new rules are too cumbersome in light of the practical realities of what the agricultural burning team is required to accomplish day in and day out. Based on the limited review in Part 2 (above) the seemingly overwhelming amount of information Ecology is being asked to evaluate is manageable and not resulting in a high error rate. Still, it's obvious that to the extent computer systems improvements can be used to better collate and display the key data and rule parameters (e.g., rolling PM 2.5 pollution levels and the threshold requirements for yellow and red sheets) then this should be done because it would further reduce the error rate. By December Ecology had developed way to display real-time monitoring data and rule action levels. This, together with an improved telemetry system for gathering the monitoring station data, should provide a valuable upgrade for the 2007 burn seasons.

Filling in the Blanks

Apart from providing public transparency, the main value of the yellow and red sheets is as a management tool. The value of the burn call and metering system is for what it can accomplish on days when region wide burning is ill-advised but targeted burning under the right local conditions can work. The yellow sheets serve the purpose of documenting burns that are authorized because of expected changes in meteorological conditions, i.e. a burn allowed on a Wednesday because stagnant air present on Tuesday is expected to be broken up by a weather front Tuesday night. While the results from the fall burn season show the system works well (there doesn't appear to be a single case where a yellow sheet burn led to a red sheet being filed) the ability to learn anything from red sheet events relies to a large extent on what is recorded on the yellow sheets.

In the case of yellow sheet #4 (9/19/06 for Starbuck/Walla Walla) the missing information about how much was burned (and where it was burned) could have made it very difficult to determine whether the burning caused elevated PM 2.5 levels or smoke complaints.

In the case of yellow sheet #6/red sheet #1, the October 28th episode in Walla Walla, it appears that the key factor in ruling out field smoke as a contributor to the elevated PM 2.5 levels that compelled the red sheet is the wind direction. Although the forecast wind direction was clearly a factor in the yellow sheet decision to allow the burning, the actual wind direction at the time of the fire (recorded in a post-burn report) is the key evidence that reasonably disconnects the burn decision from the air pollution event. Absent that information (it was not entered on the red sheet because the red sheet was filed before the post-burn report was in hand) it gives the misleading appearance that the field burn caused the red sheet.

Appendix A: Review tasks

STEP 1, Review Ecology performance in terms of the whether decisions to allow burning (YELLOW SHEET EVENTS) resulted in significant additional deterioration of air quality in affected areas (RED SHEET EVENTS).

STEP 2, Analyze RED SHEET events, if any, to discern patterns, trends, or important lessons learned.

STEP 3, Review data subset of five smoke monitoring network sites to evaluate whether Ecology missed YELLOW SHEET and RED SHEET events.

STEP 4, Evaluate smoke complaints

STEP 5, Evaluate issues involving transparency and manageability.

STEP 6, Provide a narrative analysis of the program's effectiveness, to date, under the new smoke management index rule. Make recommendations, if necessary, to improve transparency and manageability.

Appendix B: Partial data reviewed for Yellow and Red Sheet analysis

Note: The "Avg." values listed in the data tables are 24-hour averages, and the "Max." values are hourly averages of PM 2.5 concentrations.

Yellow Sheet #1

	Date	Avg.	Max.
Ritzville	9/08	23	36
	9/09	4	7
	9/10	5	6
LaCrosse	9/08	25	42
LaCrosse	9/09	4	8
LaCrosse	9/10	6	8
Rosalia	9/08	25	33
Rosalia	9/09	5	28*
Rosalia	9/10	3	5

Pullman	9/08	34	52
Pullman	9/09	5	18*
Pullman	9/10	16	28

*The Max. Rosalia value was registered at midnight, day of burn, and had decreased to 6 by 3 a.m. The Max. Pullman value on the 9th was also registered at midnight preceding the burn. The level had dropped to 5 by 3 a.m. as the weather system moved through.

LaCrosse	9/11	31	72
	9/12	25	53

Yellow Sheet #2

	Date	Avg.	Max.
LaCrosse	9/12	5	7
	9/13	25	53
	9/14	4	7
Rosalia	9/12	11	21*
	9/13	5	10

*Before burn occurred

Pullman	9/12	26*	45*
	9/13	4	9

Additional notes:

The 11th was a no burn day in Washington. The 12th was a very high burn day in Idaho. Not clear why Walla Walla was listed on the Yellow Sheet.

Yellow Sheet #3

S. of Colton Whitman Zone 3 42 acres

	Date	Avg.	Max.
Pullman	9/13	4	9

Pullman	9/14	8	18*
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***Thursday afternoon, day after burn. The morning numbers were below 5. This was a 42 acre bluegrass burn (allowed because of the slope exception).**

Yellow Sheet #4

	Date	Avg.	Max.
Starbuck	9/18	10	25
	9/19	5	9
	9/20	4	5

Yellow Sheet #5

Starbuck	9/18	10	25
	9/19	5	9
	9/20	4	5

All of Eastern Washington (burning allowed region-wide) because a strong weather front was predicted to pass through by the afternoon.

	Date	Avg.	Max.
LaCrosse	10/23	9	11
	10/24	8	13
	10/25	6	5
Rosalia	10/23	11	21
	10/24	9	15
	10/25	6	7
Pullman	10/23	10	15
	10/24	8	14
	10/25	4	6
Starbuck	10/23	11	15
	10/24	8	14
	10/25	5	10
Walla Walla	10/23	14	25*
	10/24	9	20
	10/25	6	25

Spokane	10/23	25	41
	10/24	15	33
	10/25	5	8

***Only the Spokane monitor was high enough on the 23rd to "trigger" the yellow sheet requirement. Thus, if burning had been metered (limited to discrete areas rather than regionally) a yellow sheet would not have been necessary.**

According to Ecology, there was a 150 acre per grower per day limit in effect at this time.

Yellow Sheet #6/Red Sheet #1

Notes: 1-3 p.m. burn in Zones 26 & 27, (East and SE of Walla Walla) 100 acre limit.

--Ventilation was forecasted to improve
--Winds predicted out of the SW

NOTE: According to Ecology, the NAM and GFS models weren't available that morning and that they were forced to rely on the ventilation model projections (both GFS and NAM) from the night before plus a "Clear Sky" plume projection that showed any smoke from burns in Zones 26 and 27 moving northeast. A post burn report from Zone 26, near Dixie, registered a SW wind at 0-4 miles per hour at time of burn, thus confirming the GFS and Clear Sky model projections.

	Date	Avg.	Max.
Walla Walla	10/27	10	21
	10/28	17	40
	10/29	7	15

Yellow Sheet #7

Burning 11 a.m.-2 p.m.

4 miles SE of St. John	30 acres
2 miles S. of Dusty	1 acre
6 miles S. of Dusty	200 acres

[From Yellow Sheet]	Date	Avg.	Max.
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LaCrosse	10/31	8	18
	11/1	15	33*
	11/2	17	25
	11/3	16	24
	11/4	3	

***4 a.m., day of burn**

Starbuck	10/31	6	12
	11/1	10	13
	11/2	18	32*
	11/3	9	24

***Highest 2-hour average was 26.5.**

Pullman	10/31	14	38
	11/1	16	21
	11/2	10	17
	11/3	7	12

(On 11/1, the higher values are weighted toward the morning, pre-burn.)

Rosalia	10/31	8	15
	11/1	17	27
	11/2	17	26
	11/3	8	15

Walla Walla	11/1	16	31
	11/2	25	31
	11/3	30	39

(No burn on 11/1 in Walla Walla)

YELLOW SHEET #8 AND RED SHEET #2

Notes from the Yellow Sheet: A weather system was forecasted. Burning that was allowed was away from populated areas, except Colfax which wanted an east wind (for a City of Colfax pile burn). [Two growers] (Zone 23 Walla Walla) would only burn if conditions were right. [One] called in and said he didn't burn.

Notes from the Red Sheet: "Called the growers who had permission to burn. NO one burned in Walla Walla Co. Was not able to get in contact with Whitman County Growers. Received no complaints. Air advisory--should have been made the day & should not have included SE WA. The forecasted weather system arrived about 18 hours late.

80 acres Zone 2, south Whitman County, Colfax 11-2

	Date	Avg.	Max.
LaCrosse	11/02	17	25
	11/03	16	24
Pullman	11/02	10	17
	11/03	7	14
Starbuck	11/02	18	32*
	11/03	9	25

*at 11 a.m.

Walla Walla	11/02	25	31
	11/03	30	39*

*Includes a two hour rolling average of 38.5, which is what draws the red sheet.

From the red sheet--

"The forecasted weather system arrived about 18 hours late."

Appendix C: Yellow Sheet detection data

In fulfilling Step #3, these are the dates, stations, and reasons for investigating whether yellow sheets should have been filed because of affirmative burning decisions.

<i>STATION</i>	<i>REASON</i>
<u>LACROSSE</u>	
August 22	24 hr Avg. on 21st
November 3 & 4	24 hr. Avg. on 11/2 and 11/3
<u>PULLMAN</u>	
None	
<u>ROSALIA</u>	
August 9	2 hr. Avg. at 7 a.m. 8/08
August 22	24 hr. Avg. on 8/21.
October 5	2 hr. Avg. at 2 p.m. on 10/4
November 19	2 hr. Avg. at 4 p.m. on 11/18
<u>STARBUCK</u>	
November 19	24 hour Avg. on 11/18
<u>WALLA WALLA</u>	
November 19 & 20	24 hr. Avg. on 11/18 and 11/19
